Science as Inquiry

Content Standard A:

As a result of activities in grades K-4, all students should develop

- **Abilities necessary to do scientific inquiry**
- **Understandings about scientific inquiry**

Content Summary

National Science Education Content Standards

K-4

Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

5-8

Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

9-12

Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

Minnesota Graduation Standards

Primary Level

Data Categorization, Classification and Recording:

Gather information to answer questions

Writing and Speaking:

Write and speak for a variety of academic and technical purposes

Shape, Space and Measurement:

Apply concepts of shape, space, and measurement to solve problems involving two- and three-dimensional shapes

Intermediate Level

Media, Observation and Investigation:

Answer questions using information gathered through direct observations, experiments, and other sources

Chance/Data Handling:

Apply concepts of chance & data analysis to evaluate information and solve problems in a familiar context

Speaking:

Speak to an audience or interact with a group

Middle Level

Controlled Experiments:

Design and conduct a controlled experiment or investigation and interpret the results

Direct Observation:

Gather information to answer scientific or social science questions

Patterns and Functions:

Analyze patterns and use concepts of algebra to represent mathematical relationships

Chance/Data Handling:

Apply concepts of chance and techniques of data handling to evaluate and solve problems

High School Level

In each of the standards the student selects within the *Scientific Applications* Learning Area, the student must demonstrate understanding and application of scientific investigation

Focus K-12

Grade	Early	Late
K-4	The focus of instruction early in this grade range is on engaging all students in teacher-guided experiences that develop the ability to ask questions, make observations, use simple tools to investigate, collect data, and communicate their findings.	The focus of instruction later in this grade range is on engaging all students in teacher-guided experiences that develop the ability to ask scientific questions, design and construct simple experiments, and communicate reasonable explanations.
5-8	The focus of instruction early in this grade range is on providing all students with an environment that stimulates students to ask their own scientific questions within the context of the curriculum, and assisting them as they design, carry out, analyze, and communicate findings from their own investigations.	The focus of instruction later in this grade range is on providing all students with opportunities to participate in full and partial inquiry activities which challenge them to apply their science knowledge, understandings, and abilities as they carry out more complex investigations and communicate results.
9-12	The focus of instruction at the high school level is on providing all students with the opportunity to develop an understanding of the nature of scientific inquiry through active participation in full, meaningful inquiry investigations directed toward learning scientific content.	The focus of instruction for students pursuing further study is on providing opportunities to participate in independent exploration of sophisticated content using the abilities and understandings of inquiry.

Close-up K-4

The focus of instruction early in this grade range is on engaging all students in teacher guided experiences that develop the ability to ask questions, make observations, use simple tools to investigate, collect data, and communicate their findings.

Inquiry experiences take advantage of young children's natural curiosity about the world around them. Students investigate properties of common objects, organisms, and earth materials. The teacher facilitates this by providing rich experiences for children which stimulate questions for exploration. Students ask questions, conduct simple investigations, and present the results to others. As questions arise, the teacher helps students conduct investigations to answer scientific questions—those that can be answered through the use of materials, the abilities to do science, and scientific knowledge. During these investigations, students use their senses and simple tools to aid their observations. Students acquire simple vocabulary for scientific phenomena based on their inquiry experiences and communicate their observations to others. Students and teachers observe established science safety procedures.

The focus of instruction later in this grade range is on engaging all students in teacher-guided experiences that develop the ability to ask scientific questions, design and construct simple experiments, and communicate reasonable explanations.

All students participate in inquiry experiences which involve asking questions, conducting simple investigations, using observations and data to construct reasonable explanations for questions, and presenting the results to others. While there is logic in this process, a step-by-step sequence or scientific method is not implied. Questions for students to investigate come from previous investigations or experiences, planned classroom activities, or questions students ask each other. To answer their questions, students, with the help of their teacher, make systematic observations, use 'fair tests', and carry out controlled experiments with one variable. The teacher monitors and models procedures as students measure temperatures, weigh and measure objects, and record their data in numerical form. With guidance from the teacher, students construct bar graphs, tables, and charts, and look for patterns in their data. Students begin to develop explanations based on their data. They check these explanations against their own experiences, data collected from other students, and scientific knowledge. They write about their experiences and communicate their investigations to others. Students and teachers observe established science safety procedures.

On Location K-4

Mr. V understands that scientific inquiry is a process that is different from other types of inquiry. Scientific inquiry is more than just looking up information or working with outside sources to find out how something works. It is an active process that includes learning how to observe. The "less is more" philosophy so prominent in the National Science Education Standards is illustrated here. The teacher has moved from having his young students learn scientific facts and information to engaging them in investigations of ideas and concepts. Finally, he has moved from activities confined to one class period (or time slot) to investigations over extended periods of time.

Children in Mr. V's kindergarten class are learning how to do scientific inquiry. Developing the ability to ask questions that lead to productive scientific inquiry requires lots of practice, so he begins his unit by helping them learn to ask good questions by providing them direct experiences with materials.

Kindergarten students have a difficult time distinguishing between questions and statements, and Mr. V's first task is to help them understand what questions are. Through the use of a "surprise box" — an opaque plastic lunch box — he helps the students learn and refine their questioning skills.

Mr. V places various familiar items inside the "surprise box" and has students ask questions to try to identify what is inside. At first their questions are unfocused and haphazard. As they gain experience and confidence they become better at asking questions which will help them find the answers they need.

Parents are invited to send in objects for the surprise box, and students who bring in objects for the surprise box answer the questions posed by their peers.

As students develop their ability to ask and answer questions, they move to free exploration of a variety of objects provided by Mr. V and those that they bring to class. This free exploration is an important aspect of scientific inquiry. In addition to free exploration in the classroom, the students explore the outdoors. Throughout the year, his students visit areas around the school to observe changes and track the comings and goings of the animals. Because of their experience in formulating good questions, students are able to discover a great deal on their own.

National Science Education Content Standards

K-4 Content Standard A

Abilities Necessary to do Scientific Inquiry

- **Ask a question about objects, organisms, and events in the environment.** This aspect of the standard emphasizes students asking questions that they can answer with scientific knowledge, combined with their own observations. Students should answer their questions by seeking information from reliable sources of scientific information and from their own observations and investigations.
- **Plan and conduct a simple investigation.** In the earliest years, investigations are largely based on systematic observations. As students develop, they may design and conduct simple experiments to answer questions. The idea of a fair test is possible for many students to consider by fourth grade.
- **Employ simple equipment and tools to gather data and extend the senses.** In early years, students develop simple skills, such as how to observe, measure, cut, connect, switch, turn on and off, pour, hold, tie, and hook. Beginning with simple instruments, students can use rulers to measure the length, height, and depth of objects and materials; thermometers to measure temperature; watches to measure time; beam balances and spring scales to measure weight and force; magnifiers to observe objects and organisms; and microscopes to observe the finer details of plants, animals, rocks, and other materials. Children also develop skills in the use of computers and calculators for conducting investigations.
- **Use data to construct a reasonable explanation.** This aspect of the standard emphasizes the students' thinking as they use data to formulate explanations. Even at the earliest grade levels, students should learn what constitutes evidence and judge the merits or strength of the data and information that will be used to make explanations. After students propose an explanation, they will appeal to the knowledge and evidence they obtained to support their explanations. Students should check their explanations against scientific knowledge, experiences, and observations of others.
- **Communicate investigations and explanations.** Students should begin developing the abilities to communicate, critique, and analyze their work and the work of other students. This communication might be spoken or drawn as well as written.

Understandings About Scientific Inquiry

- Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.
- Scientists use different kinds of investigations depending on the questions they are trying to answer. Types of investigations include describing objects, events, and organisms; classifying them; and doing a fair test (experimenting).
- Simple instruments, such as magnifiers, thermometers, and rulers, provide more information than scientists obtain using only their senses.
- Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations.
- Scientists make the results of their investigations public; they describe the investigations in ways that enable others to repeat the investigations.
- Scientists review and ask questions about the results of other scientists' work.

Minnesota Graduation Standards

Primary Level

Data Categorization, Classification and Recording:

Gather information to answer questions.

What students should do:

1. Gather information to answer questions through the following methods:
   a. media sources
   b. direct observation
   c. interviews
   d. experiment or investigation
2. Record information (e.g., graphs, diagrams, maps)
3. Display information using the appropriate format (e.g., graphs, diagrams, maps)
4. Explain the answer(s) to the question

In Addition:

1. Use appropriate technology to handle and display data.
2. Teacher should provide guidance in framing questions.
3. Performance package must include at least three tasks; each task must ask a different question and use a different information-gathering method.
4. Tasks may be combined with standard in writing and speaking in order to communicate findings.
5. Students must demonstrate basic safety procedures and skills when using tools and equipment.

Writing and Speaking:

Write and speak for a variety of academic and technical purposes.

What students should do:

1. Teach someone how to perform an action or create a product:
   a. write directions with multiple steps
   b. sequence steps accurately
   c. use task-specific vocabulary
   d. write list of necessary materials (e.g., string, bag, wire)
   e. use illustrations or visuals as a teaching aid
2. Write a story:
   a. describe ideas or events from personal experience, observation or imagination
   b. sequence ideas or events (e.g., beginning, middle, end)
   c. use details or examples to create images
3. Write a report to describe and give information about a person, an object or a situation
4. Give an informal oral presentation:
   a. present an opinion or idea
   b. use reasons or examples to explain it
   c. respond to related questions from the audience

In Addition:

Final written products must be easily read. A few errors in mechanics and spelling may be tolerated if they occur in newly learned or complex structures.

Shape, Space, Measurement:

Apply concepts of shape, space and measurement to solve problems involving two-and three-dimensional shapes.

What students should do:

1. Demonstrate an understanding of patterns:
   a. describe, extend and complete existing patterns
   b. create new patterns
   c. represent spatial patterns pictorially and/or numerically
   d. identify and/or create symmetrical patterns
2. Demonstrate an understanding of measurement, given familiar objects:
   a. identify type of measurement required
   b. estimate measurement
   c. select appropriate tools and units of measurement
   d. measure accurately
   e. use measurements to order a group of objects according to size
3. Demonstrate an understanding of familiar two- and three-dimensional shapes:
   a. identify shapes in real world contexts
   b. draw and/or build familiar shapes
   c. sort and classify shapes
   d. predict the results of flipping, sliding or turning a shape
4. Use geometric terms to describe spatial relations

In Addition:

1. Allow the use of a calculator or computer in problem-solving situations.
2. Geometric and visual patterns must be included.